H20-9-3

Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, Tennessee 37830

Y/HG-0119

October 26, 1982

Mr. David McKinney
Assistant Basin Manager
Division of Water Quality Control
Tenn. Dept. of Public Health
1522 Cherokee Trail
Knoxville, TN 37920

APPROVED FOR PUBLIC RELEASE
4/4/94
Technical Information Office Date

Dear Mr. McKinney:

SUBMISSION OF DOE ACQUIRED DATA RELATING TO METALS AND ORGANICS LEVELS IN LOCAL FISHERY AND SEDIMENTS

In response to your letter of September 26, 1982, enclosed is the raw data reasonably available pertaining to metals and organics levels in fish and sediments local to the DOE, Oak Ridge Operations. The data are subsequent to 1963 - the closing of Melton Hill Dam. These data are being hand delivered to you on October 26, 1982 at your office. A tabulation of the reports containing the raw data is enclosed.

Also enclosed is a paper, "Review of Mercury in Fish Data from East Fork Poplar Creek," which reviews and considers the ecological and human health impact of mercury in fish data generated from a May 6 and 7, 1982 fish survey conducted by the Oak Ridge National Laboratory. It is the paper's conclusion that the mercury in fish levels in East Fork Poplar Creek do not pose any threat to human health or the environment. This situation has not changed significantly since 1977 when it was discussed with Earl Leming and TVA.

It is our belief that, after your review of the submitted data, you will conclude that the environmental quality of the Clinch River and its environs is in a satisfactory state.

Sincerely,

J. F. Wing

J. F. Wing, Chief
Environmental Protection Branch
Safety and Environmental
Control Division

SE-331:GJM

Enclosures

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Review of mercury in fish data from East Fork Poplar Creek: A review of the Preliminary Report, ORNL/CF-82/257, "Mercury contamination in East Fork Poplar Creek and Bear Creek."

Y/HG-0119

1. Oak Ridge National Laboratory Sampling Program

On May 6 and 7, 1982, scientists from the Oak Ridge National Laboratory collected samples of bluegill (Lepomis macrochirus) from four locations along the approximately fifteen mile length of East Fork Poplar Creek (EFPC). The fish collection stations were located as follows:

Station Number	Site Description	Creek Mile
1	Approximately 500 m downstream of confluence with Bear Creek	1.3
5	Immediately south of the intersection of Montana Avenue and the Oak Ridge Turnpike	8.3
7	Approximately 100 m downstream of the large stormwater inlet mentioned for Station 8	14.1
8	Between New Hope Pond discharge point and first large stormwater inlet on west bank approximately 50 m downstream	14.2

Because the weight distribution of fish collected was different between sampling sites, the mercury data were normalized to account for the weight of the fish. The concentrations were normalized to a per fish weight of 63 grams. The length of a 63 gram bluegill is approximately 16 cm, the minimum size that a sport fisherman is likely to keep for eating.

The captured bluegill were filleted and samples of axial muscle and skin were utilized in the analyses for mercury. The analytical results, on a sampling station basis, were generated as follows:

EFPC Stream Sampling Station	Mean Weight (g)	Un-normalized Mean Total Mercury Concentration (ug/g Fresh Weight)	Normalized Mean, Total Mercury Concentration (ug/g Fresh Weight)
1	32.5	0.56	0.66
5	54.6	1.39	1.45
7	61.1	1.56	1.66
8	62.7	2.13	2.13

Mercury concentrations in fish from contaminated environments have been shown to vary seasonally, with the annual maximum occurring in later spring-early summer and the annual minimum occurring in late fall-early winter. (Tennessee Valley Authority. 1972. Mercury concentrations in fish flesh, May 1970-May 1972, Survey of TVA reservoirs. Division of Environmental Research and Development, Water Quality Branch, Tennessee Valley Authority, Chattanooga, TN. 40 pp.)

Therefore, on an annual average basis, the concentration of mercury in bluegill in EFPC is on the order of:

EFPC Stream-sampling Station	Annual Average, Normalized by Weight, Total Mercury Concentration (ug/g Fresh Weight)
1	0.50
5	1.09
7	1.25
8	1.60

2. Analysis of EFPC data with respect to the Food and Drug Administration Action Level for mercury in fish..

The Food and Drug Administration (FDA) action level for mercury in fish is discussed in detail in the Federal Register (FR) issues of December 12, 1974 and January 19, 1979.

The FDA Action Level is an administrative agency action level. The FDA purposefully announced that an administrative level was warranted because it was expected that new information on an appropriate level of mercury in food would be generated. An administrative level affords the FDA more ability to change the level than a regulatory level. On 12/6/74, the action level was formally set in the F.R. at 0.5 ppm CH_3Hg(MeHg) measured as Hg in the edible portions of fish and shellfish. On 1/19/79, the action level was relaxed to 1.0 ppm. This was the result of new data published in 1978 providing comprehensive and detailed information on fish consumption as reported by the National Marine Fisheries Service. In the FR of 1/19/79, p.3992, col.2, the FDA indicates that a 1.0 ppm level would be protective to the public and yet provide economic benefits to the fishing industry. Note the trade-off concept of standard setting.

The FDA, as a regulatory agency, is empowered to regulate fish and shellfish in commerce, specifically interstate commerce. EFPC is not a commercial fishery by any stretch of the imagination. EFPC is not much of a sport fishery either. The low fishing pressure is

probably a result both of limited access, particularly in the upstream reaches, and of poor water quality and marginal fish habitat in the downstream reaches below the City of Oak Ridge West End Sewage Treatment Plant, located at Creek Mile 8.0. Another major factor is probably the proximity of the attractive Melton Hill Lake fishery and the proximity of many other nearby state stocked creeks and lakes.

As indicated in the FR of 1/19/79, p.3992, the lowest blood level which induces the appearance of signs and symptoms of MeHg poisoning has been determined to be on the order of 200 ppb, 0.2 ppm. MeHg tends to be rather completely absorbed from food and is distributed rapidly throughout the body. Average biological half life 70 d. After a year of constant dosing of MeHg by ingestion, the body burden becomes essentially constant. In the steady state case, the concentration of MeHg in the body is proportional to the daily intake.

Therefore, according to the FR, a blood level of 200 ppb would be reached with a minimum daily intake of 300 ug Hg as MeHg in diet. The FDA, as a goal, tries to provide a safety factor of ten. Therefore, the FDA indicates that the desirable maximum level of mercury is 20 ppb in blood, or 30 ug MeHg in the daily diet.

As indicated in the FR of 12/6/74, the 0.5 ppm action level was established in 1969. Page 42739, col.1, relates the 20 ppb in blood "no clinical effects level with a safety factor of 10," to a 70 kg standard man ingesting 30 ug per day of MeHg.

As further developed in the FR, if 60 grams of fish contaminated to 0.5 ppm were eaten daily, then the acceptable dose limit, 30 ug/d MeHg would be attained. This would be a yearly dose of 10,950 ug MeHg.

The National Marine Fisheries Service (NMFS), per FR 12/6/74, P.42739, col.2, determined, early in the 1970's, that only 1.8% of the national population consumed more than 60 grams of fish per day (21,900 grams/year). The NMFS survey indicated that 1% of the participants in the survey consumed an average of 77 g.fish daily and that 0.1% consumed 165 grams daily. In the words of the 12/6/74 FR, "At the very high consumption of 165 grams per day, the tenfold margin of safety is reduced to less than four; although it [the safety factor] may be increased above that figure by the additional margin resulting in consumption of fish and shellfish with less contamination than 0.5 ppm Hg." Note, therefore, the lack of iron-clad protection for all members of the population to the factor of 10 degree of safety. It is also interesting to note that the NMFS study indicated that the national average consumption of fish was on the order of one third of 60 grams per day; namely 20 grams per day. Therefore, for the average citizen, the FDA action level

provides a margin of safety of about 30. The FR of 1/19/79 indicated that the prime reason for changing the action level for mercury in fish to 1 ppm was the realization that Americans ate far less fish than had been originally thought. This was the result of review of the NMFS survey included in "Report of the Chance of U.S. Seafood Consumers Exceeding the Current Acceptable Daily Intake for Mercury and Recommended Regulatory Controls," February 8, 1978.

In relation to NMFS surveys, it is reasonable to assume that those members of the U.S. population who consume more than 60 grams per day of fish (<1.8% of the population) probably live near the seashore and the great national fisheries and fish markets. East Tennesseeans would not be expected to lie within this population segment. EFPC is not even a great sportsman's fishery and would not be expected to supply a large number of fish to the general population, or any individual.

Oak Ridge is probably not a city of numerous intensive sport fishermen, sport fishermen who might spend many days each year fishing in EFPC. A relatively affluent city for East Tennessee, a city characteristically populated by scientists and engineers (who have other life-pursuits than habitual sports fishing) it seems conservatively quite reasonable to conclude that not even half of the 30,000 population might be sport fishermen or eat sport fish to any notable degree. This consideration should be overlain, later, in the following tables and narrative development.

Any individual who might exist in Oak Ridge who consistently ate fish from EFPC would reach his annual preferred dose limit of 10,950 ug MeHg through ingestion of:

EOR SAMPLING STATION 8:

$$10{,}950\ \frac{\text{ugHg}}{\text{yr}} \times \frac{10^6 \text{ug fish}}{1.6\ \text{ugHg}} = 6.84 \times 10^9\ \text{ug}\ \frac{\text{fish}}{\text{yr.}} = 6.84 \times 10^3\ \text{g}\ \frac{\text{fish(raw)}}{\text{yr.}}$$

$$6.84 \times 10^3 \text{g}\ \frac{\text{fish}}{\text{yr}}\ \frac{\#}{454\ \text{g}}\ \frac{16\ \text{oz.}}{\#}\ \frac{\text{meal}}{4\ \text{oz.}^*} = 60\ \frac{\text{meals}}{\text{year}}$$

(over one meal/week and preserves a full factor of 10 margin for protection.)

Assuming that no bluegill is kept below a weight of 63 g. and length 16 cm and assuming 68% of weight is edible,** then a meal would consist of:

$$4.0\ \text{oz.}\ \frac{\text{raw* meat}}{\text{meal}}\ \frac{\#}{16\ \text{oz.}}\ \frac{454\ \text{g}}{\#}\ \frac{\text{fish}}{63(.68)\ \text{grams meat}} = 2.65\ \frac{\text{fish}}{\text{meal/person}}$$

$$2.65\ \frac{\text{fish}}{\text{meal}} \times 60\ \frac{\text{meals}}{\text{year}} = 159\ \text{large enough}\ \frac{\text{fish}}{\text{year}}\ \text{--caught \& eaten}$$

(* and ** next page)

* Assume 4 oz. of raw meat cooks down to 3.5 oz. cooked. A 3.5 oz. serving of cooked tuna, for example, is considered to be one serving.

** ORNL studies indicate that typically 68% of a bluegill is edible.

Similar calculations can be performed for the other sampling stations:

Amount of EFPC Bluegill that Must be Eaten to Provide An Annual Mercury Dose of 10,950 ug/year, Preserving the FDA Desirable Safety Factor of Ten - Per Person Basis

Station No.	Meals/yr	Meals/week	Fish Caught & Eaten/year
1	192	3.7	509
5	88	1.7	233
7	77	1.5	204
8	60	1.2	159

3. Further Analysis:

The original 0.5 ppm action level considered the ingestion of 60 grams of 0.5 ppm contaminated fish to provide a sufficient factor 10 margin of safety. Those who ate more fish, e.g. $\leq$ 0.1% of the population, were afforded a margin of safety of less, on the order of 3.64. Based on the NMFS study of February 8, 1978, the FDA relaxed the action level to 1.0 ppm., Hg. Undoubtedly, the same degree of protectiveness was retained with changing the action level to 1.0 ppm. Therefore, about $\leq$ 1.8% of the national population consumes more than thirty grams of fish per day.

One can generate the following table, TABLE I - next page for EFPC Station 8.

Bases:

a. An annual dose of 109,500 ug generates a clinical effect.

b. The product 1.0 ppm x 30 g $\frac{\text{fish}}{\text{day}}$ provides a dose of 10,950 ug/gr.

c. Annual fish consumption distribution in Oak Ridge parallels that of the U.S. This is a very conservative assumption since Oak Ridge is not a major fishery.

d. All fish eaten by citizens of Oak Ridge come from EFPC. This is also extremely conservative.

TABLE I

A. Concentration Level	B. Fish Consumption	C. % Population that Eats More Fish	D. Safety Margin $\left(\frac{109{,}500 \text{ ugHg/yr}}{\text{Col.A} \times \text{Col.B} \times 365}\right)$
1.0 ppm	30 g/d	<1.8	10
1.0 ppm	38.5 g/d	<1.0	7.79
1.0 ppm	82.5 g/d	<0.1	3.64

All the above are considered acceptable risks by FDA, per the Federal Register

Station 8 EFPC:

1.6 ppm	30 g/d	<1.8	6.25
1.6 ppm	38.5 g/d	<1.0	4.87
1.6 ppm	82.5 g/d	<0.1	2.27

1.6 ppm @ 38.5 g/d is within the safety margin allowed by FDA (i.e. 4.87 vs. 3.64).

$$38.5 \text{ g/d} \times 365 \frac{\text{d}}{\text{y}} \times \frac{16 \text{ oz}}{454 \text{ g}} \frac{1}{4 \text{ oz.}} = 124 \text{ meals/year of EFPC fish is acceptable,}$$

(about 2.4 meals/week EFPC fish), according to FDA criteria.

Table II below presents results for other EFPC sampling stations - it was developed with the same methods utilized in Table I.

TABLE II

Station 7 EFPC

Concentration	Fish Consumption	Population %	Safety Margin
1.25 ppm	30 g/d	<1.8	8
1.25 ppm	38.5 g/d	<1.0	6.2
1.25 ppm	82.5 g/d	<0.1	2.9

Station 5 EFPC

Concentration	Fish Consumption	Population %	Safety Margin
1.09 ppm	30 g/d	<1.8	9.2
1.09 ppm	38.5 g/d	<1.0	7.1
1.09 ppm	82.5 g/d	<0.1	3.3

Station 1 EFPC

Concentration	Fish Consumption	Population %	Safety Margin
0.5 ppm	30 g/d	<1.8	20
0.5 ppm	38.5 g/d	<1.0	16
0.5 ppm	82.5 g/d	<0.1	7.3

Note that fish of <1.0 ppm for the 82.5 g/d consumer meets the "action level" requirement yet does not provide a full margin of ten buffer.

From the FR of 12/6/74, it is apparent that FDA considers an annual dose of:

1.00 ppm x 82.5 x 365 = 30,112.5 ug MeHg/yr = (0.5 ppm x 165 g x 365) to be acceptable for small (< 0.1%) segments of the population.

Therefore, an FDA acceptable dose would be reached in eating the following amount of fish from worst case Station 8,....

$$30{,}112.5 \quad \frac{10^6 \text{ ug fish}}{1.6 \text{ ugHg}} = 1.88 \times 10^4 \text{g} \quad \frac{\text{fish}}{\text{yr}} \quad (51.5 \text{ g/d})$$

$$1.88 \times 10^4 \text{ g fish/yr} \quad \frac{16 \text{ oz.}}{454 \text{ g}} \quad \frac{\text{meal}}{4 \text{ oz.}} = 166 \text{ meals/year, or } 3.2 \text{ meals/week}$$

$$4 \text{ oz. } \frac{\text{meat}}{\text{meal}} \cdot \frac{454}{16} \times \frac{\text{fish}}{63(.68)\text{grams meat}} = 2.65 \frac{\text{fish}}{\text{meal/person}}$$

$$2.65 \frac{\text{fish}}{\text{meal}} \quad 166 \frac{\text{meals}}{\text{year}} = 440 \frac{\text{fish}}{\text{yr/person}}$$

Using the above methods, the following Table can be generated:

Table III

Amounts of EFPC Bluegill that Must be Eaten to Provide An Annual Mercury Dose of 30,112.5 ug/year, Which Conveys an FDA Approved Acceptable "Margin of Safety" from Clinical Effects of Mercury of 3.64 - Per Person Basis

Station No.	Meals/year	Meals/week	Fish Caught & Eaten/yr
1	531	10.2	1407
5	244	4.7	647
7	212	4.1	563
8	166	3.2	440

To the extent that other fish in an Oak Ridger's diet displace EFPC fish, the annual dose of Hg would be moderated. Fish in interstate commerce must be less than 1.0 ppm mercury. Tuna averages at around 0.3 ppm mercury.

Conclusions

While mercury concentrations in EFPC are higher than background measurements made from Melton Hill Reservoir fish, they do not pose a toxicity hazard. The FDA action level does not apply to individual fish, but rather to the average annual average of all fish consumed. The action level is based on a consumption rate three times the national average plus an additional safety factor of ten as well. An overall safety factor of 30 results. Thus, while some fish in EFPC exceed the action level, an extraordinarily high and protracted consumption rate of these fish would be needed in order to reach levels of concern.

EFPC's ecological condition ranks from poor to fair. It probably does not contain a substantial number of edible sport fish. Populations may be so small that it may be quite difficult for one individual to catch enough fish from the upper reaches to significantly dose himself to exceed FDA recommended annual doses for mercury. The upper reaches of EFPC are particularly difficult to access, or located near major thoroughfares, such as to make them particularly unattractive to sport fishermen.

Given the sociological makeup of Oak Ridge, it is quite unlikely that anyone has the time or the economic need to catch and eat over 159 large bluegill per year from the area of sampling station No. 8, and thus jeopardize the "factor of ten" margin of safety inherent in the FDA protective action level. A person would have to catch and eat over 440 fish per year (~3.2 meals/week) to exceed the FDA margin of safety of 3.64 which the FDA believes provides adequate protection for 0.1% of the population.

The consideration of the above factors leads to the conclusion that the intensity of fishing in EFPC does not warrant concern that health risks are being created in the population of Oak Ridge.

Y-12 DATA

Preliminary Study, Mercury Contamination In East Fork Poplar Creek and Bear Creek, 1982

Mercury in Fish 1978 - Fish From: Melton Hill, East Fork Poplar Creek, Clinch River, Rogers Quarry, and New Hope Pond

Fish Analysis 1977 - Mercury Heavy Metals

Mercury in Fish 1977 - Poplar Creek, Clinch River

Mercury in Fish 1977 - Popular Creek

East Fork Poplar Creek 1970-1976

Mercury Content of Fish Samples 1976, Poplar Creek, Melton Hill Lake

Mercury in Fish 1976, Melton Hill Lake, Clinch River, Poplar Creek

Mercury in Fish, Poplar Creek 1976

Mercury Fish, Clinch River 1976

Preliminary Aquatic Survey East Fork Poplar Creek and Bear Creek, 1975

Preliminary Aquatic Survey of East Fork Poplar Creek and Bear Creek 1974

Preliminary Aquatic Survey of East Fork Poplar Creek and Bear Creek 1973

Aquatic Survey East Fork Poplar Creek and Bear Creek 1973

Preliminary Aquatic Survey of East Fork Poplar Creek and Bear Creek, 1972

ORGDP DATA

Memorandum from W. Van Winkle to M. Mitchell dated October 14, 1982

Poplar Creek Fish Sampling Data, Special Sampling Program, 1982 Only

Clinch River and Poplar Creek Fish Sampling Data, Special Sampling Program, 1977 Only

Clinch River and Poplar Creek Fish Sampling Data, Special Sampling Program, 1976 Only

Clinch River and Poplar Creek Bottom Sediments Data, Special Sampling Program, 1979 Only

Clinch River and Poplar Creek Bottom Sediments Data, Routine Sampling Program, 1975-1981

Bottom Sediments Data for Selected Streams and Ponds on Oak Ridge DOE Reservation, Special Sampling Program, 1974 Only

ORNL DATA

ORNL Drawing 81-9373

ORNL Drawing 81-9374

Clinch River Sediment Data - Appendix A

ORNL/TM-6714-1981 - Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant

Y/UB-16 - Environmental Monitoring Report, U.S.DOE, Oak Ridge Facilities, Calendar Year 1981

Y/UB-15 - Environmental Monitoring Report, U.S.DOE, Oak Ridge Facilities, Calendar Year 1980

ORNL/TM-7509/V2-1979 - Technical Background Information for the ORNL Environmental and Safety Report, Volume 2

Y/UB-13 - Environmental Monitoring Report, U.S.DOE, Oak Ridge Facilities, Calendar Year 1979

ORNL/TM-6895-1978 - Association of Radionuclides with Streambed Sediments in White Oak Creek Watershed

Y/UB-10 - Environmental Monitoring Report, U.S.DOE, Oak Ridge Facilities, Calendar Year 1978

Y/UB-8 - Environmental Monitoring Report, U.S.DOE, Oak Ridge Facilities, Calendar Year 1977

Y/UB-6 - Environmental Monitoring Report, U.S.ERDA, Oak Ridge Facilities, Calendar Year 1976

ORNL-5169 - Applied Health Physics and Safety Annual Report for 1975

Y/UB-4 - Environmental Monitoring Report, U.S.ERDA, Oak Ridge Facilities, Calendar Year 1975

ORNL-5055 - Applied Health Physics and Safety, Annual Report for 1974

UCC-ND-302 - Environmental Monitoring Report, U.S.ERDA, Oak Ridge Facilities, Calendar Year 1974

ORNL-4974 - Applied Health Physics and Safety, Annual Report for 1973

UCC-ND-280 - Environmental Monitoring Report, U.S.AEC, Oak Ridge Facilities, Calendar Year 1973

ORNL-4894 - Applied Health Physics and Safety, Annual Report for 1972

ORNL-4848 - Environmental Sciences Division, Annual Progress Report, Period Ending September 30, 1972

ORNL-4795 - Applied Health Physics and Safety, Annual Report 1971

ORNL-4445-UC-48-Biology and Medicine

ORNL-4423-UC-41-Health and Safety, Applied Health Physics and Safety Annual Report for 1968

ORNL-4316, UC-41-Health and Safety, Health Physics Division, Annual Progress Report for Period Ending July 31, 1968

ORNL-4286-UC-41-Health and Safety, Health Physics and Safety, Annual Report for 1967

ORNL-4035-UC-70-Waste Disposal and Processing-1967, Clinch River Study

ORNL-3721, Supplemental 2B, UC-70-Waste Disposal and Processing, 1967, Radioactive Materials in Bottom Sediment of Clinch River: Part B, Inventory and Vertical distribution of Radionuclides in Undisturbed Cores

ORNL-3721, Supplement 2A, UC-70-Waste Disposal and Processing, Radioactive Materials in Bottom Sediment of Clinch River: Part A, Investigations of Radionuclides in Upper Portion of Sediment

ORNL-4007-UC-41-Health and Safety, Health Physics Division Annual Progress Report for Period Ending July 31, 1966

ORNL-4146-UC-41-Health and Safety, Health Physics and Safety Annual Report for 1966

ORNL-3969-UC-41-Health and Safety, Health Physics and Safety Annual Report for 1965

ORNL-3849-UC-41-Health and Safety TID-4500 (44th ed.), Health Physics Division Annual Progress Report for Period Ending July 31, 1965

ORNL-3721, UC-70-Waste Disposal and Processing, TID-4500 (44th ed.), 1965, Status Report No. 5 on Clinch River Study

ORNL-3820-UC-41-Health and Safety, TID-4500 (41st ed.), Applied Health Physics Annual Report for 1964

ORNL-3697, UC-41-Health and Safety, TID-4500 (34th ed.), Health Physics Division Annual Progress Report for Period Ending July 31, 1964

ORNL-3665-UC-41-Health and Safety, TID-4500 (31st ed.), Applied Health Physics Annual Report for 1963

ORNL-3492-UC-41-Health and Safety, TID-4500 (22nd ed.), Health Phsycis Division Annual Progress Report for Period Ending June 30, 1963

ORNL-3409,UC-70-Waste Disposal and Processing, TID-4500 (21st ed.), 1963, Status Report No. 4 on Clinch River Study